JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

VOL. 9 APRIL 4, 1919 No. 7

OPTICS.—*Trigonometric computation formulae for meridian rays.* P. V. WELLS, Bureau of Standards. (Communicated by S. W. Stratton.)

The design of optical instruments is notoriously so laborious and complicated that any simplification of notation, or shortening of labor, is important. By far the largest amount of labor is spent in tracing the actual path of selected rays through the tentative system by means of the trigonometric formulae. These formulae are simplest for logarithmic computation when referred to the center of curvature of the refracting surface instead of to its vertex. This is doubtless known to many designers but as I have not seen it in the literature, it may be useful to others.

The resulting formulae, using the notation defined in figure 1, where the subscript k refers to the k'th surface are:

$$\sin \theta_K = \frac{c_K}{r_K} \sin \alpha_K \qquad (1)$$

$$\sin \theta'_K = \frac{n_K}{n_{K+1}} \sin \theta_K \qquad (2)$$

$$\alpha_{K+1} = \alpha_K + \theta'_K - \theta_K \qquad (3)$$

$$c'_K = r_K \frac{\sin \theta'_K}{\sin \alpha_{K+1}} \qquad (4)$$

$$c_{K+1} = c'_K + d_{CK} \qquad (5)$$

Where $c_K = r_K - u_K$, $c'_K = r_K - u'_K$, and $d_{CK} = d_K + r_{K+1} - r_K$ (6)

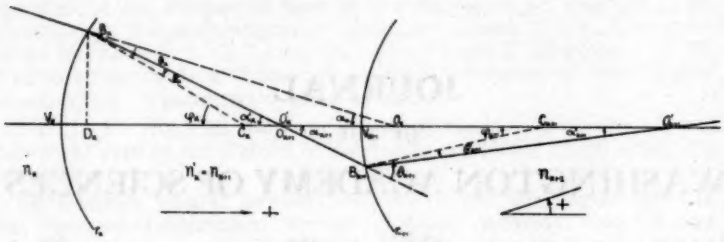

FIG. 1.—NOTATION.

Symbols referring to the object-space are unprimed, to the image-space are primed, the image-space for the k'th surface becoming the object-space for the (k + 1)'th surface.

K'TH REFRACTING SURFACE.

n_k = index of refraction, object-space.

n'_k = index of refraction, image-space.

VERTEX DISTANCES.

$r_k = \overline{V_kC_k}$ = radius of curvature.

$u_k = \overline{V_kO_k}$ = object distance.

$u'_k = \overline{V_kO'_k}$ = image distance.

$C_k = \overline{O_kC_k}$ = object distance (to center).

$C'_k = \overline{O'_kC_k}$ = image distance (to center).

$d_k = \overline{V_kV_{k+1}}$ = interval between vertices.

$d_{ck} = \overline{C_kC_{k+1}}$ = interval between centers.

SLOPE ANGLES.

$\varphi_k = \angle B_kC_kV_k$ = slope angle of normal at incidence point.

$\alpha_k = \angle B_kO_kV_k$ = slope angle of incident ray.

$\alpha'_k = \angle B_kO'_kV_k$ = slope angle of refracted ray.

$\theta_k = \angle O_kB_kC_k$ = angle of incidence.

$\theta'_k = \angle O'_kB_kC_k$ = angle of refraction.

$h_k = \overline{D_kB_k}$ = incidence height (measured positively upward).

IDENTITIES.

$$n'_k = n_{k+1}.$$

$$\alpha'_k = \alpha_{k+1}.$$

There are two special cases which require consideration: (1) when u_K is infinitely great, and (2) when r_K is large (greater than ten times the focal length). In the first case, since $\varphi_K = -\theta_K$ when $u_K = \pm \infty$

$$\sin \theta_K = \frac{-h_K}{r_K}. \tag{7}$$

In the second case both c_K and c'_K are large. The formula usually given for this case, immediately derived from (1), (4), and (6), is

$$u'_K = u_K \frac{\sin \alpha_K}{\sin \alpha_{K+1}} \cdot \frac{\cos {}^1/_2(\alpha_{K+1} + \theta'_K)}{\cos {}^1/_2(\alpha_K + \theta_K)}. \tag{8}$$

The angles are computed as usual, and u_K is computed from the formula

$$u_K = r_{K-1} - c'_{K-1} - d_{K-1}. \tag{9}$$

The transfer of origin back to the center is made by use of (5) and (6), thus

$$c_{K+1} = r_{K+1} - u'_K + d_K. \tag{10}$$

There are apparently two special cases: (1) when the incidence is nearly normal, that is, when θ_K is small, and (2) when the refracted ray is nearly parallel to the axis, that is, when α_K is small, but in both cases formulae (1) to (5) may be used. Although c_K and c'_K are small when θ_K is small no precision is lost in c_{K+1} or in α_{K+1} which do not change in order of magnitude. Similarly when α_{K+1} is small no loss of precision occurs unless the interval between centers, d_{CK}, is large. This is evident from an expression of $\sin \theta_{K+1}$ which may easily be derived from (4), (5), and (1), namely

$$r_{K+1} \sin \theta_{K+1} = r_K \sin \theta'_K + d_{CK} \sin \alpha_{K+1}.$$

When α_{K+1} is small, θ_{K+1} is determined by θ'_K and the r's. The angles θ and α are both small only when r is large, a case which has just been considered in formula (8).

The theory of optical instruments is burdened by too much diversity in matters of convention. It seems inadvisable to depart from the time-honored conventions of geometry and trigonometry. Thus distances measured from left to right,

and angles measured by anti-clockwise rotation, are taken as positive in the notation of this paper.

The vertex of each surface is taken as the origin for its radius and for the object and image distances in refraction at that surface. The slope angles are measured from the rays in to the optic axis, and from the normal (to the surface at the incidence point) in to the axis, and the angles of incidence and refraction are measured from the rays in to the normal. Hence r and φ, u and α, u′ and α', and θ and θ' group in pairs having like sign. As r is measured toward the center of curvature, it is convenient to measure both c and c′ toward the center. They are defined by equations (*6*), which have the advantage of symmetry as regards the signs of u and c.

The quantities $\frac{1}{r_K}$, r_K, and d_K are constants for each surface, and their logarithms may be computed in a special column, copied on a slip of paper, and used directly for all rays. Similarly the logarithms of the ratios $\frac{n_K}{n_{K+1}}$ may be separately computed for each wave-length and used for all the rays of the same color.

For paraxial rays the angles θ and α are small quantities of the first order, so that sin θ may be replaced by θ, and cos θ by unity. In this case the θ'*s* and α'*s* may be eliminated from equations (*1*) to (*4*), giving the Gauss formula

$$c'_K = \frac{n_K r_K c_K}{n_{K+1} r_K - (n_{K+1} - n_K)c_K}. \qquad (11)$$

If one must work alone, the constants may be checked by computing the paraxial rays both by (*1*) to (*4*), replacing the sines by the angles, and also by (*11*). Decimal trigonometric tables are most convenient, such as those published by the French government.

RADIATION.—*Note on the coefficient of total radiation of a uniformly heated enclosure.* W. W. COBLENTZ, Bureau of Standards.

Under the above title the writer published[1] a value of the so-called Stefan-Boltzmann constant of radiation from a uniformly heated enclosure or so-called black body. The value is $\sigma = 5.72 \times 10^{-12} \pm 0.012$ watt cm^{-2} deg^{-4}. It is based upon about 600 measurements, made with 10 receivers, which are summarized in table 6 of a previous publication.[2] The data obtained with receivers nos. 8 and 9 were not included because the apparatus was defective. The data obtained with these 10 receivers were corrected for radiation lost by reflection, which loss amounts to 1.2 per cent for receivers covered with lampblack (soot) and 1.7 per cent for receivers covered with platinum black. It does not include a set of measurements made on an unblackened radiator. The reflection from a receiver covered with platinum black, then smoked, is 1.2 per cent. These corrections were determined by direct measurements upon some of the receivers and by comparison of the surfaces of the other receivers with samples of lampblack whose reflection losses had been determined in a previous investigation.[3]

Experiments were made on atmospheric absorption and it was shown that if any correction to these data for atmospheric absorption is to be made, it can hardly be greater than 0.1 per cent.

Recently a new determination[4] of this radiation constant was brought to my attention, and in view of the fact that this paper contains inaccurate statements concerning my own work a few comments are permissible. For example, the statement is made that the only novelty in the apparatus employed by Coblentz and Emerson (*loc. cit.*) was a thermopile with a continuous receiving surface, which is of secondary importance. As a

[1] Proc. Nat. Acad. Sci. 3: 504. 1917.
[2] COBLENTZ and EMERSON. Bull. Bur. Stand. 12: 549. 1916.
[3] Bull. Bur. Stand. 9: 283. 1913.
[4] KAHANOWICZ. Nuovo Cimento (6) 13: 142. 1917.

matter of fact, the crucial part of the apparatus was a receiver with potential terminals attached thereto, at a sufficient distance from the ends to avoid the question of heat conduction to the electrodes. These potential wires, which were from 0.003 mm. to 0.02 mm. in diameter, accurately defined the length of the central part of the receiver which was utilized in the measurements. By exposing the whole length of the receiver to radiation, conduction losses did not enter the problem. The writer is not aware of anyone having used a similar apparatus which compares with this receiver in nicety of construction, and reproducibility of results under given conditions.

The receiver used by Kahanowicz was placed at the center of a spherical mirror, with an opening in one side to admit radiation. In this manner the correction for reflection was eliminated. The shutter was close to the receiver. If its temperature was different from that of the water-cooled diaphragm, which was before the radiator, errors in the radiation measurements would occur. As mentioned in my previous papers, the shutter should be placed between the water-cooled diaphragm and the radiator, to avoid a change in surroundings facing the receiver when the shutter is raised for making the radiation measurements. The temperature range was from 260° C. to 530° C. The distance from the radiator to the receiver was 35 to 55 cm. A series of 28 measurements gave an average value of $\sigma = 5.61 \times 10^{-12}$ watt cm^{-2} deg^{-4}. Of this number 11 gave a value of $\sigma = 5.7$. Out of a series of 4 measurements made in December, 1916, with the distance $d = 56$ cm., three gave a value of $\sigma = 5.7$.

No corrections were made for atmospheric absorption, which for the temperatures used is not negligible. In a previous paper[5] it was shown that on removing the moisture (vapor pressure of 10 to 12 mm.) from a column of air 52 cm. in length, the radiation constant was increased from $\sigma = 5.41$ to 5.55 or about 2.6 per cent. For the spectral region transmitted by rock salt, to $\lambda = 15\mu$, the absorption is about 1 per cent.[6] Other

[5] Bull. Bur. Stand. 12: 576. 1916. See table 3, series CLXXX to CLXXXII.
[6] Proc. Nat. Acad. Sci. *Loc. cit.*

measurements mentioned in these papers indicate an absorption of 2 to 3 per cent of the radiations emitted at 1000° C. for the average humidity of Washington.

Dr. H. H. Kimball, of the U. S. Weather Bureau, very kindly sent me comparative data, showing that the vapor pressures at Naples are considerably higher than at Washington. From these data it would appear that the correction for atmospheric absorption must be at least 1 per cent. For the low temperatures at which the radiator was operated, a fair estimate of the correction to the radiation data obtained by Kahanowicz is 1.5 to 2 per cent, or a value of $\sigma = 5.69$ to 5.72×10^{-12} watt cm^{-2} deg^{-4}. In other words, the Naples value of the coefficient of total radiation is comparable with other recent determinations which indicate a value of $\sigma = 5.7 \times 10^{-12}$ watt cm^{-2} deg^{-4}.

BIOLOGY.—*What kind of characters distinguish a species from its subdivisions?*[1] WILLIAM C. KENDALL, Bureau of Fisheries.

I do not claim to be an authority on Taxonomy, although I have labored to some extent in Systematic Ichthyology, which for a long time was to me a game of "follow the leader," and in which game, it may be said, I was a "blind" follower.

The fixed views of my leaders, regarding what kind of characters should constitute species and subspecies respectively, seemed thoroughly reasonable and logical, but when independently I attempted to apply them in practice, I found myself in a dense fog from which I have not yet emerged.

Briefly stated, a species was such by virtue of possessing one or more "distinct and constant" characters distinguishing it from all other species. These characters might be pronounced or slight, but if "constant" entitled the form so characterized to a binomial label. Of course if there was only one specimen, which was commonly the case, the above specific condition was fulfilled.

If, however, two forms, which, if observed by themselves in two separate localities, would seem to be distinct species, should

[1] Remarks at the Symposium at the meeting of the Biological Society, Saturday, March 8, 1919.

be found to intergrade geographically in characters from one terminus to the other, the one later described or named should be regarded as a subspecies and be given a trinomial name.

My preceptors further impressed upon me that a species and its subspecies could not develop in exactly the same environment.

I further learned that two forms though differing but slightly and suspected of intergradation should continue to be regarded as distinct species until intergradation should be proved.

As previously indicated, I subscribed to all this and am still willing to accept those *dicta* as gospel, and let them go at that. But the fog still hangs low. For that reason I cannot throw any light upon the question before us tonight. Beyond that which I have just stated no definite plan of procedure seems to have been advanced by any ichthyologist. In fact there seems to be no uniformity and little consistency in ichthyological classification, especially as pertains to species and the minor divisions of species.

I have more than once read or heard it stated that there is no such thing as species. If this be so, it would seem that there is a widely prevalent illusion and the systematists are seeing things. This would seem to be borne out by the fact that even certain recognized leaders appear to adhere to no definite system. In the same work one may find subspecies, species, and even genera based upon exactly the same kind or degree of differences, also good and valid species, according to the previously mentioned definition, considered identical with another species.

Unfortunately, or rather, fortunately if you please, we are limited to two sorts of names for the minor divisions of classification: binomial for species; trinomial for subspecies.

As I conceive of the objects of nomenclature, it is to afford a means of concisely designating certain situations. In regard to this point the question before us tonight seems to me to be: How many of the various situations, if more than one, shall be included in the binomial and how many in the trinomial designation? For it must be recognized that if the previously mentioned definitions of species and subspecies are accepted without modifications or limitation, there are several situations for which no provision has been made.

Ichthyologically, I, myself, discern two kinds of phantoms, which I designate as species. One is a taxonomic species, the other a natural species. At times they may blend into one but not always. Both conform to the definition given by my leaders and both imply development of one form from another, but there are two lines of development or derivation to be considered which I will designate as horizontal and vertical. The first refers to derivation, development, and relationships on the surface plane of a given time, past or present. The second, to derivation and development in time from the past to the present. Any cross-section of the vertical will present a horizontal plane of development. In taxonomic considerations of species and their subdivisions of living fishes, the tendency appears to be to regard them in their horizontal aspect. That is, in their relations to each other in the period of time in which they exist. If the vertical is considered at all it is usually as though the organism of the past was the same as the present. For instance, it is stated that *Salmo salar sebago* is derived from *Salmo salar*, as though the parent stock was the same as the Atlantic salmon of today. It may or may not have been. That is a point to be considered vertically. My meaning may become clearer if we imagine a longitudinal section through the vertical from the past to the present time.

During some period of time, recent or remote, through limitations to interbreeding and other causes, it is conceivable that two horizontal extremes developed differences of character which graded in toward the center. The persistence to the present time of these interbreeding connections constitute a perfect intergradation geographically between the two extremes of the present time. Again, it is conceivable that by expansion geographically of one or the other or both of the differentiating extremes, there is an actual or relative contraction of the intermediate connections. In other words, there is a tendency toward segregation of the extremes through weakening of the interbreeding connections.

Both phylogenetically and taxonomically in this situation at the present time there can be only one species, notwithstand-

ing the fact, that, if we were ignorant of the existence of the connecting forms, the two extremes would be sufficiently different to be regarded as distinct taxonomic species.

Phylogenetically the form at the center of distribution would typify the species. The fact that one extreme or the other may be the center of distribution does not affect the question. Unfortunately the species of the present-day taxonomist is often already named and may have come from any point in the hypothetical area mentioned. It may or may not be one or the other extremes or it may or may not represent the center of distribution. Consequently a subdivision of the species may in like manner represent almost any point more or less remote from the locality represented by the taxonomic species. In fact, according to his niceties of discrimination or his idiosyncrasies, one might make any number of subspecies, or whatever subdivisions of a taxonomic species it is decided to call these geographical representatives of a single natural species.

Now, if the two lines of differentiation, previously mentioned as developing at each margin or extreme in more or less remote time, should gradually separate, leaving a gap in the intergradation thus restricting the interbreeding to two independent lines of further development, which proceed without further interruption to the present time, they would result in two related natural species, conforming to the specific taxonomic definition of species of the aforesaid authorities. The degree of difference between these two species would depend, partly at least, upon the remoteness of the period of divergence.

One of these independent lines, at one period or another, may have repeated either one or both of the previously mentioned situations. The more recent the divergence, the less distinct the differences, until at the present time they are perhaps almost indistinguishable from the first mentioned horizontal or real intergradation. In fact, they may be quite indistinguishable to the systematist having before him only small collections or collections from a few localities only.

Again, suppose that, in some past period of time, more or less remote, a small portion of one of the main divergent lines of

development, progressing without a differentiation at the margin, should be segregated—put off at a way station, so to speak—and, by virtue of little or no change of environment, should be retarded or arrested in its phylogenetic development. Then suppose that, at a later period, similar segregation takes place, which for like reasons is also retarded or arrested. Both of these forms, persisting in their isolation and limited interbreeding to the present day, to the horizontal observer would appear as two intermediate forms, that is to say, connecting links between the respective species resulting from each of the main lines of phylogenetic development, previously referred to. The result of the first mentioned segregation would resemble the species at the present end of the main line other than the one resulting from the line in which the segregation originated, more nearly than would the result of the later segregation. So, although they appear as intermediate forms between existing species, they are not. They represent, rather, vertical intermediates between the common ancestral stock and the one species at the present end of the line from which they themselves were segregated. They form no intergradation, continuous nor interrupted, between the living species, but between an ancestral species different from the present species, and are, therefore, living fossils as it were. They may have, and probably did pursue, some small degree of development themselves. They should, I believe, be regarded as distinct species.

In my hypothesis I have designated only two of this latter character. There might be many. The more there are, the more difficult would it be to recognize the situation. But when the intergradation is interrupted, as it is in these instances, and particularly where each form is somewhat isolated at the present time, as in such instances it is likely to be, I believe that specific definition of my leaders fit the cases. The interruptions are represented by certain characters, which, whether little or great, entitle the forms to specific designation. They are natural species and should be thus taxonomically recognized.

There occur to me two other situations that might be, in fact have been, mistaken for real intergradations.

One is due to the intermingling and interbreeding of two closely related species. It represents a reunion across lots of long separated relatives. Of course, the intergrading forms are hybrids and there is no question regarding the distinctness of the species producing them or the designations of the results of their crossing. The real problem is in recognizing the situation.

The other situation is that of degradation due to degeneration of certain characters. The irregularity of distribution of the various degrees of such degeneration, and the fact that all degrees, from apparently perfect individuals to extreme degeneration of parts or characters, are sometimes found in one locality, suggest physiological or pathological causes and are individual rather than specific or subspecific in their significance. Such forms are even now recognized as species or subspecies, but with no more justification than there would be in regarding a group of human beings affected with alopecia as constituting a distinct race. "A man's a man for a' that."

The foregoing hypothetical situations are all represented among fishes today, but are generally not correctly interpreted. Only correct diagnoses of these cases render practicable the uniform application of the previously mentioned definitions of species and subspecies. Then, "true intergradation" designates subspecies. All the other situations are specific.

EVOLUTION.—*Evolution through normal diversity.* O. F. COOK, Bureau of Plant Industry.

Mr. F. L. Lewton, of the United States National Museum, has brought to my attention a paper by Thomas Meehan, which contains the following passage:

> The observations on this plant (*Impatiens fulva*) confirm records I have made during the past quarter of a century that there is an innate power to vary coexistent with the species itself, independent of any conditions of environment. This may be granted without prejudice to the proposition that changes can and do occur at times by the influence of environment, for which there is abundant evidence. It seems proper to present the strong facts on the former side, because of the modern tendency to exalt the latter as the prime motor in evolution.[1]

[1] *Contribution to the life-histories of plants, No. X.* Proc. Acad. Phila. 1894: 53.

The statement and its context are significant, and the issue is fundamental, though obscured by much deductive reasoning. Inheritance of "acquired characters," the changes that are directly imposed or induced by the environment, is no longer credited, but the environment is still supposed to cause evolutionary changes indirectly, through the medium of selection. It has been argued in many ways that evolution must be due to environmental causes, but such inferences do not visualize against a biological background. Not only is current dialectic unclear in failing to recognize elementary distinctions between causal and conditional relations, but essential facts continue to be neglected and dangerous applications entertained, such as the theory of natural selection used in Germany to justify the war.

Historical interest may be claimed for the passage from Meehan on account of the definite recognition of normal diversity. The expression "power to vary" may be misunderstood as assuming a mysterious "principle" or hidden "mechanism of evolution," but evidently it refers to the concrete, visible fact of diversity as the general and normal condition among the members of species. "The variations must be from some natural law of evolution inherent in the plant itself" was an earlier expression of the same idea that normal evolutionary diversity is a general fact, not determined by environment.[2]

Darwin recognized variation as a general fact, but he was wont to consider the environment as the cause, and the belief in environmental causation became completely dominant in the minds of many of his followers. Meehan's conception of variation as independent of the environment was framed many years in advance of the formal recognition of heterism or normal diversity among the members of species as a general evolutionary fact. Owing to the preponderance gained by the Darwinian interpretation, the word variation had come with many writers to refer almost exclusively to differences of accommodation to environmental conditions. The new word heterism seemed

[2] T. MEEHAN. *On the agency of insects in obstructing evolution.* Proc. Acad. Phila. 1872: 237.

necessary as a means of referring definitely to the class of differences which Meehan had described as "innate," "inherent," and "coexistent with the species itself." In proposing the name heterism additional examples were given, and the phenomenon was associated with more specialized forms of diversity that are admitted generally to be independent of the environment, as sexes, castes, and dimorphic or polymorphic species.[3]

Darwin had made much of the agency of insects in developing the highly specialized floral organs of orchids and other plants, and such adaptive specializations had been accepted as evidence that the environment, acting through natural selection, is the active agent in evolution. Meehan's observations and reasoning led to the opposite view, that crossing by insects would tend to keep the species uniform, and would thus interfere with evolution, instead of carrying it forward. To him it appeared that special characters might develop more rapidly if peculiar strains were kept separate, instead of being crossed by insects.

Efforts have been made to demonstrate the power of selection to induce changes of characters, but without finding any consistent evidence. Progress appears to be made in cases where the desired variations occur, but there is nothing to show that variations in a particular direction can be induced by dint of selection, after a pure-bred stock has reached a condition of uniformity. Statistical investigators often assume that causal effects are demonstrated by proving that the average of any particular character can be raised by selective elimination, but it remains to be shown that there is anything definitely evolutionary in the shifting of averages. To hold logically the idea that selection is the actuating cause of evolution, it must be assumed that the selective elimination or cutting away of one character or part of a species causes the other parts to vary farther away from the selective stress, an assumption not supported by definite evidence.

Apart from the mutation theory, the alternatives of selective causation of evolution are the Lamarckian idea of direct influence

[3] O. F. Cook. *Aspects of kinetic evolution.* Proc. Wash. Acad. Sci. 8: 244. 1907.

of the environment, to which Darwin himself often inclined, and the idea of spontaneous variation within the species put forward by Meehan in opposition to Darwin. As a lifelong observer, familiar with many genera and species and large numbers of living plants, Meehan was competent to give testimony and he took an important step beyond Darwin in perceiving that diversity inside the species is independent of the environment. Nevertheless, the evolutionary bearing of diversity was still obscured because Meehan shared with Darwin the mistake of supposing that contrasted characters must tend to disappear, through the alleged "swamping effect of intercrossing," an idea that continues to be accepted by many because it appears reasonable from mathematical or statistical points of view. Galton's "law of ancestral regression" has been taken as a mathematical demonstration of the reality of a swamping effect.

In recent years the law of regression has been applied to alternative inheritance as well as to quantitative or blended characters, and no longer seems to require the assumption of an underlying tendency for the members of an interbreeding group to reach a stable or uniform condition. Inheritance is seen to be alternative rather than equational, as shown by intensive studies of Mendelism and other methods of descent. Many divergent or contrasted characters persist in hybrid populations, instead of being obliterated or averaged away to uniformity. Even when the hybrid offspring are closely alike in the first or conjugate generation, ancestral differences may reappear undiminished in the perjugate generations.

The so-called recessive characters that can be transmitted for many generations without coming into expression, as well as reversions or reappearances of characters of remote ancestors, afford striking evidence that transmission is distinct from expression, and that transmission is permanent, while expression is readily changed. Phenomena of variation and diversity are largely differences of expression, including accommodations, or varied expressions of adaptive characters, to suit different conditions of existence.

It was necessary to discard the idea of diversity being lost through crossing, before it could be understood that new characters might be preserved in natural species without the individuals being segregated, by selection or otherwise. Preserving the adaptive variations no doubt facilitates evolution in directions of increased fitness, but the argument from fitness is far from proving that changes of characters are caused by selection. We say that cold weather makes us put on overcoats, but not that overcoats are made by cold weather. Species become adapted through variation. Each separate group is a distinct evolutionary system for developing new characters, some of adaptive value and others not. How characters are originated and preserved in transmission are questions that relate to the mechanism of heredity, but the nature of the mechanism of evolution is obvious. A very effective way of extending and combining any characters that variation may afford is provided by the organization of each species into a continuous fabric of lines of descent, united through sexual reproduction.[4]

Endless individual diversity results from the continued development and gradual diffusion of inherited characters among the members of a species. To find the diagnostic characters, those that are shared by all the members of one species but are absent from related species, often requires very patient and persistent work by systematists. Sometimes it is impossible to determine, even from many specimens, whether one species or more than one is represented. The groups must be canvassed in nature to learn whether they are continuous or not, so great and multifarious are the individual differences, while the general similarities are obscure and difficult to state.

With diversity accepted as a normal and general condition in species, evolution is seen as a process of continous integration and differentiation of characters. The two essential conditions of evolutionary progress are normal diversity (heterism) and free intercrossing of lines of descent (symbasis), as in natural

[4] O. F. Cook. *The vital fabric of descent.* Proc. Wash. Acad. Sci. 7: 301–323. 1906. See also, *Methods and causes of evolution,* U. S. Dept. Agr. Bur. Pl. Ind. Bull. 136. 1908.

species of plants and animals. The most familiar example of heterism is the individual diversity of mankind, but the same condition is recognized as soon as we become sufficiently familiar with the members of other species of animals or plants. Diversity is reduced or eliminated temporarily by selective breeding, or propagation in single or narrow lines, but reappears when the natural condition of free interbreeding is restored. Instead of tending to impede evolution, intercrossing of lines of descent in species presents a condition most favorable for the preservation and extension of new characters. The development of multitudes of useless differences is the best evidence of spontaneous development of useful characters. "The prime motor in evolution," to use Meehan's words, "is an innate power to vary, coexistent with the species itself, independent of any conditions of environment."

Laboratory geneticists may believe that species consist normally of uniform, identical individuals, or may suppose that the members of species tend to become uniform or to remain uniform if placed under the same environmental conditions, but these assumptions are not based on familiarity with natural species. Theories may be projected and logical systems deduced from the assumption of uniformity, as though a world of uniform species really existed, just as mathematicians follow relations of symbols into space of four dimensions. Facts are often obscured by elaboration of conventional ideas. Wider application of biology in agriculture, eugenics, and sociology awaits clearer perception and presentation of the underlying evolutionary and environmental relations.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. The abstracts should conform in length and general style to those appearing in this issue.

PHYTOPATHOLOGY.—*Some of the broader phytopathological problems in their relation to foreign seed and plant introduction.* BEVERLY T. GALLOWAY. Phytopathology 8: No. 3. March, 1918.

In this paper the author briefly reviews the progress in organized coordinated medical sanitation and emphasizes the results in their relation to plant sanitation; outlines the history of plant-exclusion legislation and points out its bearing on systematic foreign seed and plant introduction; and describes the present intensive work for the protection of new plant introductions against diseases and other enemies and suggests the approaching necessity of similar work for the country at large.

Certain principles are recognized in the work of the Office of Foreign Seed and Plant Introduction:

(1) That the work is international, and the broad phytopathological problems require world-wide consideration and study from the economic as well as from the phytopathological standpoint.

(2) That regulatory and restrictive measures, which are only palliative at best, must be internationalized to be most effective, and as such measures are generally highly profitable when properly administered they should receive the best support.

(3) That the science of plant hygiene, or the study of crops in relation to environment, offers the broadest field for research and applied science, and that this science will doubtless supplant many prevailing practices in phytopathology as preventive treatment is supplanting curative practices of the old-school physician.

The need of phytopathological surveys—local, national, and international—is strongly evidenced in the agricultural exploration work, so strongly in fact that the question arises as to whether the risk of introducing injurious diseases and insects is not too great to warrant general agricultural explorations and consequent seed and plant introductions, with no check except the necessarily imperfect examinations after the material arrives.

Agricultural exploration and introduction work is an important function of the Government, but the time seems to be approaching when these explorations should be back-grounded by phytopathological surveys or the explorations and phytopathological work done simultaneously. Theoretically plants should be free from diseases and insects, and, although theoretically only, there is no reason why efforts should not be made to approach the ideal conditions in this respect.

The development of some phases of plant hygiene will require combined effort and coordinated action of pathologists and others. Systematic world-wide studies of the botanical relationships of some of our principal crops seem desirable, not only to obtain a foundation for intelligent action regarding the economic use of plants, but to aid in supplying material with which to fight our present plant enemies.

The gradual shifting of plant industries from one region to another is also an interesting study and is due in many cases to lack of proper appreciation or understanding of plant sanitation. Sanitation as a phase of hygiene must be considered. The removal of many causes of disease is practicable, but a vast amount of educational work must be done in this field before effective action can be secured. The individual can accomplish much, but only through the State can far-reaching results be brought about. The State, however, is moved in such matters only by a groundswell of public opinion, and the best way to create a groundswell for plant sanitation is to bring the individual grower to a realization of its importance in all phases of his work.

B. T. G.

GENETICS.—*A study of hybrids in Egyptian cotton.* THOMAS J. KEARNEY and WALTON G. WELLS. Amer. Nat. 52 : 491–506. Oct.-Nov., 1918.

Hybrids were made between two varieties of Egyptian cotton, Pima and Gila, both of which had presumably originated by mutation. The two varieties, as represented by the progenies grown from selfed seed of the individuals which were the parents of the hybrids, differed significantly in their means for some two dozen characters. Most of these are size or shape characters. The parental ranges for nearly all characters overlapped considerably.

With very few exceptions, the means of the simple intervarietal hybrids, in the first, second, and third generations, fell between the parental means. The $^{7}/_{8}$ backcrosses obtained by twice crossing the

simple hybrid with either parent were practically identical with the preponderant parent in the means and ranges of the characters studied.

The simple hybrids showed little or no evidence of dominance in the F_1 nor of segregation in definite ratios in the F_2, the F_2 distributions having been, practically without exception, unimodal. None of the hybrid plants appreciably exceeded the combined parental ranges in respect to any character, while in the F_2 of wider crosses, *e. g.*, between Egyptian and Upland cottons, extraparental characters are abundantly expressed.

The second and third generations of the simple hybrids, as compared with the parents after two and three generations of selfing, were not more variable than the more variable Gila parent and were only a little more variable than the Pima parent. This points to the possibility of obtaining relatively stable and uniform recombinations of the desirable characters of varieties belonging to the same general type, while breeders have found it well-nigh impossible to "fix" wider crosses such as those of Egyptian (or Sea Island) with Upland cotton.

T. H. K.

ZOOLOGY.—*The criterion of subspecific intergradation in vertebrate zoology.* HARRY C. OBERHOLSER. Science, n. ser. **48**: 165–167. 1918.

Intergradation is now generally accepted as the criterion of zoological subspecies. What constitutes subspecific intergradation, however, seems to be still debatable, particularly that kind of intergradation represented by individual variation in a form geographically separated from all other races of the species. This is illustrated by the case of *Aphelocoma californica* and *Aphelocoma californica sumichrasti*, the ranges of which are widely separated by intervening forms which have not, in all cases, direct geographic intergradation, although the individual variation in the latter overlaps that in the former. If in such cases we are to consider the two forms as distinct species, we must, to be consistent, treat all island and isolated alpine forms as distinct species however slightly and inconstantly they may be differentiated. The logical course, however, seems to be to consider this individual variation as equivalent to contiguous geographical intergradation, and thus regard individual variation as one of the chief criterions of subspecific intergradation.

H. C. O.

MAMMALOGY.—*The Wisconsin Napaeozapus.* HARTLEY H. T. JACKSON. Proc. Biol. Soc. Wash. **32**: 9–10. February 14, 1919.

The cooperative field work of the U. S. Biological Survey and Wisconsin Geological and Natural History Survey during the summers of 1917 and 1918 resulted in the collection of seven specimens of *Napaeozapus* from four localities in northern Wisconsin. This is a definite westerly extension of the previously known geographic range of the genus. The Wisconsin animal represents a clearly defined form which is named *Napaeozapus insignis frutectanus.* H. H. T. J.

ENTOMOLOGY.—*The case of the genera Rhina and Magdalis.* W. DWIGHT PIERCE. Proc. Ent. Soc. Wash. **20**: No. 4. Pp. 72–78. September 27, 1918.

This article straightens out a peculiar nomenclatorial tangle of these two genera, and gives tables of the subgenera of *Magdalis* and of the North American species of the genus. This is the first attempt at a coordination of the European and American classifications of this group. W. D. P.

ORNITHOLOGY.—*The migration of North American birds. III. The summer and hepatic tanagers, martins, and barn swallows.* HARRY C. OBERHOLSER. Bird Lore **20**: 145–152. 1918.

The tables of migration data in this paper concern the following species, together with their subspecies: *Piranga rubra, Piranga hepatica, Progne subis,* and *Hirundo rustica.* By means of these tables it is possible to trace the migratory movements of these species both in spring and in autumn, from north to south. In addition, the breeding and winter ranges of each of the species and subspecies are given, together with the same information for *Progne cryptoleuca* and *Progne chalybea,* both of which, however, cannot be considered as of regular occurrence in North America. The average of arrival and departure at the various localities are in some cases based on records extending over as many as thirty-two years, though in most cases considerably less. H. C. O.

ORNITHOLOGY.—*The common ravens of North America.* HARRY C. OBERHOLSER. Ohio Journ. Sci. **18**: 213–225. May, 1918.

The subspecies of the common raven, *Corvus corax* Linnaeus, are among the most difficult birds of the family Corvidae. The differ-

ences characterizing them are almost wholly those of size and proportion, and, because great individual variation complicates the case, these are largely average distinctions and require series of specimens for proper elucidation. In the old world some sixteen or seventeen forms are at present recognized, but in North America currently only two, *Corvus corax principalis* of northern North America, with which the birds in the eastern United States are considered identical, and *Corvus corax sinuatus* of the western United States and Mexico. In addition to these, another smaller form, *Corvus corax clarionensis*, recently described from Clarion Island in the Revillagigedo group, of western Mexico, now appears to be the race inhabiting western North America from Lower California and Arizona to Oregon. The bird of eastern North America from Alabama to southern Labrador, and west to Minnesota and Arkansas, is described as a new race—*Corvus corax europhilus*. H. C. O.

ORNITHOLOGY.—*Birds observed near Minco, central Oklahoma.* ALEXANDER WETMORE. Wilson Bull. **30:** 2–10, 56-61. 1918.

Lists of breeding birds from Oklahoma are particularly important since little information is available concerning the geographic distribution of birds in this state. This contribution comprises notes on sixty-two species and subspecies, mostly breeding birds from the vicinity of Minco, in the central part of the State. The most interesting information from a distributional standpoint is the residence here of *Penthestes carolinensis agilis, Muscivora forficata, Agelaius phoeniceus predatorius, Dryobates pubescens medianus*, and *Thryomanes bewickii cryptus*; and the occurrence during migration of *Chordeiles minor henryi*. HARRY C. OBERHOLSER.

ORNITHOLOGY.—*Notes on the genus Puffinus Brisson.* HARRY C. OBERHOLSER. The Auk **34:** 471–475. October, 1917.

The notes in this paper relate to the generic groups, species, and subspecies currently included in the genus *Puffinus* Brisson, particularly such as concern North America. The new genus *Calonectris*, proposed by Mathews and Iredale for *Puffinus leucomelas* and *Puffinus kuhlii*, appears to be well characterized. The genus *Ardenna* Reichenbach is likewise tenable and includes *Puffinus gravis* O'Reilly, *Puffinus creatopus* Coues, and also *Puffinus carneipes* Gould, which has recently been made

by Iredale the type of a new but untenable genus, *Hemipuffinus*. For *Puffinus cuneatus* Salvin and *Puffinus chlororhynchus* Lesson, a separate generic group seems necessary, for which the name *Thyellodroma* Stejneger is available. Neither the proposed genus *Alphapuffinus* Mathews, to include *Puffinus assimilis*, *Puffinus lherminieri*, and *Puffinus persicus*, nor *Neonectris* Mathews, proposed for *Puffinus tenuirostris tenuirostris*, *Puffinus tenuirostris brevicaudus*, and *Puffinus griseus*, are generically separable from typical *Puffinus*. The action of Mathews in renaming the *Puffinus opisthomelas* of Coues as *Puffinus couesi* and the transference of the name *Puffinus opisthomelas* to the species commonly known as *Puffinus auricularis* proves to be unwarranted, since an examination of the types of both *Puffinus auricularis* and *Puffinus opisthomelas* show that they belong, respectively, to the species to which the names have commonly been applied. The *Puffinus couesi* of Mathews therefore becomes a synonym of *Puffinus opisthomelas* Coues. Furthermore, the subspecies of *Thyellodroma cuneata* (Salvin) recognized by Mr. Mathews prove to be, on re-examination of pertinent material, all untenable. H. C. O.

TECHNOLOGY.—*Toluol recovery.* R. S. McBride, C. E. Reinicker, and W. A. Dunkley. Bur. Stand. Tech. Paper No. 117. Pp. 60. 1918.

The importance of high explosives in the present war has been amply demonstrated. Nearly all types of explosives are used in some way, but trinitrotoluol, commonly known as T. N. T., because of its high power and great stability, is one of the preferred explosives. As an important constituent in shells, T. N. T. is used both alone and mixed with other explosives. Especially for naval use it is used alone, because the greater stability permits longer storage of the shells before use. On account of the great demand for T. N. T. there has grown up also a large demand for those materials for which it is made, especially toluol. This material finds numerous applications in the chemical industries, but particularly it has been used in the manufacture of dyestuffs and for the preparation of T. N. T. For this latter it is only necessary to treat the toluol with nitric acid under proper conditions in order to produce the explosive, which is then refined by appropriate means to such degree of purity as is required for the use for which it is intended. R. S. M.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

The Board of Managers met on February 24, 1919. Mr. FREDERICK V. COVILLE was elected vice-president to represent the National Geographic Society. A committee consisting of A. S. HITCHCOCK, ADOLPH KNOPF, and W. R. MAXON was appointed to recommend to the Board alternate plans for the sale of the *Proceedings* of the ACADEMY.

The meeting of the Board on March 10, 1919, was devoted to the consideration of nominees for membership.

ROBERT B. SOSMAN, *Corresponding Secretary.*

BOTANICAL SOCIETY OF WASHINGTON

The 134th regular meeting of the Society was held at the Cosmos Club at 8 p.m., Tuesday, March 4, 1919. Forty-eight members and six guests were present. Mr. G. HAMILTON MARTIN, JR., of the Bureau of Plant Industry, was elected to membership. The program consisted of the following papers:

A botanical trip to the Hawaiian Islands (with lantern): Prof. A. S. HITCHCOCK. During the summer and fall of 1916, the speaker visited the Hawaiian Islands, including in his travel the islands of Hawaii, Maui, Oahu, Kauai, Molokai, and Lanai. Hawaii, the largest island, is about 100 miles wide and contains about 4000 square miles. On this are the two highest peaks, Mauna Kea (13,825 feet) and Mauna Loa (13,675 feet), and the active volcano or lava pit, Kilauea. On Maui is the great crater of Haleakala, said to be the largest in the world. Honolulu is on Oahu; the Leper Colony on Molokai.

The three important industries are the raising of sugar, stock, and pineapples. The ranches are located mostly on Hawaii, Maui, Molokai, and Lanai, the largest being about 700,000 acres. As there are few streams or wells in the drier parts of the islands the water supply is, for the most part, rainwater stored in tanks.

The introduced ornamental trees and shrubs are numerous and conspicuous, and introduced weeds have supplanted the native flora in the vicinity of the inhabited parts of the island. Among the important or peculiar plants of the islands may be mentioned the koa (*Acacia koa*), a common and useful native forest tree; the algaroba (*Prosopis juliflora*, introduced from America; the lobelias, consisting of about 100 species and 5 genera of Lobeliaceae, most of the species being

arboreous and often palm-like in appearance; the silver sword (*Argyroxiphium sandwicense*), a composite with beautiful silvery leaves, growing on the bare lava slopes of Haleakala; and the apé (*Gunnera petaloidea*), of the family Halorrhagidaceae, with enormous circular leaf-blades. The ferns are very numerous in species and individuals, often dominating the flora, especially in wet regions. The tree ferns are conspicuous. They produce at the base of the leaf-stalk a mass of yellow wool called pulu, which is used for stuffing pillows.

Vegetation of Paradise Key and the surrounding Everglades (with lantern): Mr. W. E. SAFFORD. Paradise Key, an island in the heart of the Everglades of Florida, nearly ninety miles south of Lake Okechobee, is of great biological interest, as an example, within the limits of the United States, of a subtropical jungle unspoiled by man. It is reached by automobile, or by train and automobile from Miami, thirty-seven miles to the northeastward. Though the temperature sometimes falls below freezing point, the mildness of its climate is attested by the presence of many tropical plants including a number of lofty royal palms whose crests may be seen from a distance above the sky line of the forest. These palms have given the name Royal Palm State Park to a tract of land including Paradise Key, some of the near-by marsh-land, and a corner of pine-land, granted to the Florida Federation of Women's Clubs by the State Legislature and afterwards augmented by the gift of a public-spirited woman. The paper, which is to be included in a forthcoming publication of the Smithsonian Institution, treats of the climate and physical geography, the various plant formations, including water-plants, plants of the marshes, marsh-loving shrubs, forest trees, lianas, epiphytes, and undershrubs, and contains a short account of some of the most interesting plants of the neighboring pine-lands, with reference to the interdependence of the animals and plants of the region discussed, their geographical distribution and dissemination, and notes as to their economic importance to the aboriginal inhabitants of southern Florida.

CHAS. E. CHAMBLISS, *Recording Secretary.*

BIOLOGICAL SOCIETY OF WASHINGTON

The 592d meeting of the Society was held in the Assembly Hall of the Cosmos Club, Saturday, February 22, 1919; called to order at 8 p.m. by President SMITH; 42 persons present.

O. P. HOPKINS, Washington, was elected to membership.

Under the heading brief notes, Prof. A. S. HITCHCOCK and Dr. A. D. HOPKINS called attention to a recently issued book on the birds of Colombia by Frank M. Chapman.

The formal program was an address by the retiring president, Dr. J. N. ROSE: *Botanical explorations in Ecuador.*

Dr. ROSE gave an account of his recent botanical explorations in Ecuador. He spent three months in that country during the past summer and obtained some 6000 botanical specimens. He made two

sections from west to east, one from Guayaquil to Ambato and the other from Loja to Santa Rosa. He also traveled down the Andean Valley from San Antonio to Loja. He showed thirty slides made from photographs obtained during this trip. One of these showed a house made of the giant bamboo which grows in the mountain canyons and which forms such an important material in the building of houses along the coast of Ecuador. Dr. Rose collected several species of cinchona, a plant which is in use for the manufacture of quinine. Specimens of cinchona bark, ivory nut, and various tropical fruits which had been preserved in formalin were on exhibition.

Discussion by Messrs. H. M. SMITH, A. D. HOPKINS, A. S. HITCHCOCK, R. M. LIBBEY and others.

M. W. LYON, JR., *Recording Secretary.*

ENTOMOLOGICAL SOCIETY OF WASHINGTON

The 320th regular meeting of the Society was held March 6, 1919, in the Assembly Hall of the Cosmos Club.

There were present 33 members and 41 visitors.

The minutes of the 319th meeting were read and approved.

Messrs. RICHARD T. COTTON and J. C. FURMAN, both of the Bureau of Entomology, were elected to membership.

The Corresponding Secretary called attention to notices that he had recently received, one from Martinus Nijhoff of the Hague announcing that, since the removal of the submarine menace, he is in position to fill old and new orders for literature; and one from the publishers of *Genera insectorum* listing the parts already published, those to appear in 1919, and those that are out of print.

The program for the evening consisted of moving pictures made by the Department of Agriculture and showing the practical application of control measures against injurious insects.

Dr. HOWARD gave a brief talk concerning the application of moving pictures to education and extension work in science especially as relating to agriculture and entomology.

The first picture showed methods and apparatus for eradicating poultry pests and a form of sanitary poultry house. Dr. PIERCE made a few preliminary remarks by way of explanation of this picture.

The second picture illustrated the fumigation of citrous trees in California, and showed the various types of apparatus in use. The legends had not yet been inserted in this picture, and it was fully explained as run off by Mr. SASSCER.

The last picture showed the eradication of the pink boll worm of cotton in Texas. During the changing of the reels Mr. BUSCK gave a brief summary of the history of the invasion of this insect into the United States, and expressed the belief that the methods shown in the picture were responsible for the absolute extermination of this very serious pest from something over 10,000 acres of land.

R. A. CUSHMAN, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

The "United States Fixed-Nitrogen Administration" has been organized under the joint control of the Secretaries of War, Navy, Interior, and Agriculture. It will be a civilian organization, and is designed to take over and operate all the federal government plants designed for the fixation of nitrogen and the manufacture of ammonia and nitric acid.

WILLIAM BOWIE, Major of Engineers, U. S. Army, was honorably discharged on February 28, 1919, and has resumed his duties as Chief of the Division of Geodesy, U. S. Coast and Geodetic Survey.

Lieut. PAUL C. BOWERS, formerly with the Chemical Warfare Service in Washington, is now at the laboratories of E. I. du Pont de Nemours and Company, at Wilmington, Delaware.

Dr. KEIVIN BURNS, of the Bureau of Standards, has returned after two months spent in visiting laboratories in Europe.

Mr. F. C. CLARK, of the paper and textile laboratories of the Bureau of Standards, left the Bureau in March and is now with the American Writing Paper Company, at Holyoke, Massachusetts.

Messrs. ARTHUR L. DAVIS and H. H. HIELD have been transferred from the Sheffield, Alabama, plant of the Nitrate Division, Army Ordnance, to the Arlington research laboratories of the Division.

Mr. L. A. FISCHER has returned to the Bureau of Standards to resume his duties as Chief of the Division of Weights and Measures. During the war he was commissioned Major in the Ordnance Department and was engaged in supervising the construction and use of munitions gages.

Mr. E. W. GUERNSEY, formerly with the Chemical Warfare Service, is now at the research laboratories of the Brown Company, at Berlin, New Hampshire.

Dr. JOHN JOHNSTON resigned as Executive Secretary of the National Research Council in March, in order to accept an appointment as Professor of Chemistry in Yale University, at New Haven, Connecticut.

Mr. J. O. LEWIS, superintendent of the petroleum experiment station at Bartlesville, Oklahoma, has been appointed chief petroleum technologist of the Bureau of Mines, to succeed Mr. CHESTER NARAMORE, who has resigned from the Bureau to join the Union Petroleum Company, at Philadelphia, Pennsylvania.

Lieut. GERALD H. MAINS has returned from active service in France to resume work at the Bureau of Chemistry.

Dr. C. HART MERRIAM has been elected chairman of the U. S. Geographic Board, as successor to the late ANDREW BRAID.

Prof. J. C. MERRIAM, of the University of California, has returned to Washington to act as Chairman of the National Research Council.

Mr. ROBERT L. MOORE, of the Bureau of Standards, has been transferred to the rubber laboratory of the Bureau at the University of Akron, Akron, Ohio.

Dr. JAMES A. NELSON has resigned from the Bureau of Entomology to take up farming near Mt. Vernon, Ohio, retaining a connection with the Bureau as collaborator.

Mr. JOHN D. NORTHROP, of the Geological Survey, resigned at the end of January to enter the employ of an oil company at Cheyenne, Wyoming.

Capt. L. W. PARSONS, formerly with the Chemical Warfare Service, is now at the Research Laboratory of Applied Chemistry, Massachusetts Institute of Technology, Cambridge, Massachusetts.

Capt. H. C. PORTER, of the Ordnance Department, U. S. A., is now with the Chemical Service Laboratories, Incorporated, at West Conshohocken, Pennsylvania.

Lieut. Col. GLENN S. SMITH sailed for the Dominican Republic in March to make a preliminary inspection of topography with the purpose of organizing a topographic survey under the direction of the military government of the Republic.

Dr. T. WAYLAND VAUGHAN, accompanied by D. D. CONDIT, C. W. COOKE, and C. P. ROSS, left New York on March 19 for the Dominican Republic, to make a preliminary inspection of the geology in preparation for a geological survey under the direction of the military government of the Republic.

Dr. H. S. WASHINGTON, of the Geophysical Laboratory, Carnegie Institution, has been elected a foreign member of the Reale Accademia dei Lincei of Rome.

A new edition of the Directory of the ACADEMY and its affiliated societies (the "Red Book") was distributed early in March.